PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H04N 3/15

A2

(11) International Publication Number: WO 99/04553

(43) International Publication Date: 28 January 1999 (28.01.99)

(21) International Application Number: PCT/FI98/00512

(22) International Filing Date: 12 June 1998 (12.06.98)

(30) Priority Data:
973042 18 July 1997 (18.07.97) FI

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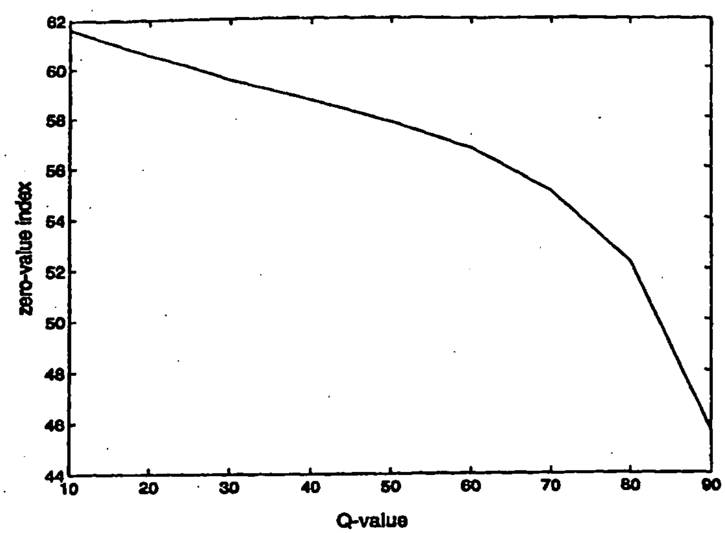
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: IMAGE COMPRESSION



(57) Abstract

A DCT based lossy compresion method for compressing a digitised image composed of a matrix of image samples to provide a compressed image which satisfies a predefined bit budget. The digitised image is first sub–divided into blocks (e.g. of size 8X8 pixels). A discrete cosine transform (DCT) comprising a set of DCT coefficients is then derived for each block. A quantisation table is selected from a set of quantisation tables and, using the selected table, the coefficients of each DCT are quantised. A zero–value index, corresponding to the average number of zero value quantised DCT coefficients per DCT, is determined. A predicted zero–value index is calculated using said predefined bit budget and a quantisation table selected from said set of tables using the determined index and the predicted index. Using that selected table, the unquantised coefficients of the DCTs are requantised and the requantised coefficients compressed using run–length encoding and Huffman encoding.

Image compression

The present invention relates to a method and apparatus for compressing a digitised image.

Currently, the most widely used standard for the compression of continuous-tone still images, both greyscale and colour, is that known under the acronym JPEG, after the Joint Photographic Experts Group. JPEG specifies *inter alia* a discrete cosine transform (DCT) based method for the lossy compression of still images.

A DCT based encoder 1 employing JPEG is shown schematically in Figure 1 (see Wallace, G.K. "The JPEG Still Picture Compression Standard" Communications of The ACM, April 1991). For a digitised greyscale image 2 which is composed of a matrix of pixel intensity values (e.g. 512X480), the image is first subdivided into 8x8 pixel blocks 3. The pixel blocks 3 are fed in sequence to the encoder 1 which has at its input a forward DCT (FDCT) unit 4. The DCT is related to the discrete Fourier transform (DFT), such that the FDCT unit 4 effectively transforms each 8x8 block 3 into 64 orthogonal basis signals or DCT coefficients, each of which corresponds to one of 64 "spatial frequencies". In effect, the DCT represents the frequency spectrum of the input block 3. The DCT coefficient with zero frequency in both dimensions is the "DC" coefficient and the remaining 63 coefficients are the "AC" coefficients. It is a general property of images that pixel intensity values vary slowly from pixel to pixel across the image. Thus, for a typical 8x8 sample block 3 from a typical source image, most of the DCT coefficients have zero or near-zero amplitude.

Following the FDCT unit 4, each DCT is provided to a quantiser unit 5 which quantises the DCT coefficients using a 64-element quantisation table stored in a table specification memory 6. The elements of the quantisation table specify the quantisation step size for respective DCT coefficients. In practice, the quantisation table used is either a 'base' table stored in the memory 6 (CCITT Recommendation T.81, "Digital Compression and Coding of Continuous-Tone Still Images - Requirements and Guidelines", Annex K) or a table generated by uniformly scaling the elements of the base table. Typically, 100 different tables are defined corresponding to a range of quality levels, Q=1 to 100, where the base table corresponds to a quality level Q=50. It is noted that within any one quantisation table, the quantisation step sizes may vary from element to element.

After quantisation, the quantised coefficients of each DCT are provided to a run length encoder 7 as a data stream, the coefficients being ordered according to increasing frequency. The run length encoder 7 takes advantage of consecutive zeros in this data stream to compress the data. As has already been noted, for a typical image block the DCT coefficients tend to be small so that, after quantisation, the number of zeros in the DCT data stream is likely to be great. Run-length encoding may therefore achieve a significant level of compression. Finally, the run length encoded data stream is provided to an entropy encoder 8, which further compresses the data stream using, for example, Huffman coding, to generate a compressed 'image' 9.

In many applications, the number of bits which can be used to represent a compressed image is predefined. One such application is the proposed transmission of still images via the short message service (SMS) provided for by the cellular telephone standard GSM. The maximum length of a single concatenated short message is 34170 (255x134) octets (or bytes). In order to allow a still image to be transmitted by a single concatenated short message, the compressed image must therefore occupy less than 34170 octets. However, because the spectral characteristics of different images can differ greatly, it is extremely hard to predict the size of the compressed image which will be produced by using a particular quantisation table (or Q value). The general practice in order to satisfy a predefined bit budget is to select a quantisation table on the basis of past experience, and to apply this to obtain a compressed image. If the compressed image does not satisfy the bit budget, a second quantisation table is selected via a quantisation table selection unit 10 and a new compressed image generated. This process is carried out on a "trial and error" basis until a compressed image is obtained which satisfies the bit budget.

It will be appreciated that the trial and error nature of the compression method outlined above is inefficient in so far as the quantisation and encoding steps often have to be repeated many times before a compressed image is obtained which satisfies the bit budget.

According to a first aspect of the present invention there is provided a method of compressing a digitised image composed of a matrix of image samples to provide a

compressed image which satisfies a predefined bit budget, the method comprising the steps of:

1) dividing the digitised image into blocks and deriving for each block an energy-packing transform comprising a set of transform coefficients;

2) selecting a quantisation table from a set of quantisation tables and using the selected table to quantise the coefficients of each transform;

3) deriving a zero-value index indicative of the number of zero-value quantised transform coefficients;

4) determining a predicted zero-value index using said predefined bit budget;

5) selecting a quantisation table from said set of tables using the derived index and said predicted index and using that selected table to quantise the coefficients of each transform; and

6) compressing the coefficients quantised in step 5) using run-length encoding.

Embodiments of the present invention enable a compressed image to be generated, which satisfies a predefined bit budget, using only a single encoding step 6).

The compressed image may be divided into blocks of any suitable size. The blocks may be contiguous or overlapping. Typically however, the blocks are contiguous and each is composed of 8x8 pixels.

Preferably, said energy-packing transform is a discrete Fourier transform (DCT). Alternative energy-packing transforms may be used however, such as a Karhunen-Loeve transform.

For a greyscale image, said image samples are greyscale intensity values. For a colour image, a matrix of image samples may be provided for each of a set of colours, e.g. red, blue, and green, and the matrices processed separately according to the method of the invention. The compressed image comprises a combination of the compressed coefficient sets. Alternatively, and in order to increase the compression ratio further, luminance (Y) and chrominance (U,V) matrices may be generated from the red, blue and green colour matrices. Again, the luminance and chrominance matrices are processed separately according to the above method.

Preferably, said zero-value index is the average number of zero-value quantised transform coefficients in the transforms. Alternatively however, the median or another representative value may be used.

Preferably, step 3) comprises deriving zero-value indices for each of a plurality of different quantisation tables to provide a zero-value index vs quantisation table relationship. It is however not necessary to requantise the transform coefficients for each additional quantisation table. Rather, the additional zero-value indices can be derived from the first obtained set of quantised coefficients.

Preferably, the method comprises obtaining a reference zero-value index vs bit budget relationship by:

7) dividing a digitised test image into blocks and deriving for each block an energy packing transform comprising a set of transform coefficients;

8) selecting a quantisation table from a set of quantisation tables and using the selected table to quantise the coefficients of each transform;

9) deriving a zero-value index indicative of the number of zero-value quantised transform coefficients;

10) compressing the coefficients quantised in step 5) using run-length encoding;

11) determining the bit size of the compressed image;

12) repeating steps 7) to 11) for a plurality of different quantisation tables to obtain a zero-value vs bit size relationship for the test image; and

13) repeating steps 7) to 12) for a plurality of different test images and combining the resulting relationships to obtain the reference zero-value index vs bit budget relationship,

wherein this relationship is used in step 4) to determine the predicted zero-value index using the predefined bit budget.

Step 5) then comprises using the predicted zero-value index and the zero-value index vs quantisation table relationship for the image to be compressed, to select the quantisation table. This selection may comprise interpolating between the zero-values of the derived set of zero-values which neighbour the predicted zero-value.

In order to ensure that the final compressed coefficient set satisfies the predefined bit budget, the selection of the final quantisation table is preferably a conservative one. For

example, the predefined bit budget may actually be less than the actual number of bits which can be transmitted, stored or otherwise processed.

Preferably, steps 6) and 10) comprise entropy encoding the data, e.g. using Huffman encoding, following run-length encoding.

According to a second aspect of the present invention, there is provided apparatus for compressing a digitised image composed of a matrix of image samples to provide a compressed image which satisfies a predefined bit budget, the apparatus comprising:

first signal processing means for dividing the digitised image into blocks and for deriving for each block an energy packing transform comprising a set of transform coefficients;

quantisation means for quantising the coefficients of each transform using a first quantisation table selected from a set of quantisation tables;

second signal processing means for deriving an index representative of the number of zero-value quantised transform coefficients, for determining a predicted zero-value index using said predefined bit budget, for selecting a quantisation table from said set of tables using the derived index and said predicted index and using that selected table to quantise the coefficients of each transform; and

encoding means for compressing the coefficients quantised by the second signal processing means using run-length encoding.

The apparatus of the present invention may be incorporated into a mobile communication device, for example a cellular phone.

For a better understanding of the present invention and in order to show how the same may be carried into effect reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows a block diagram of a DCT-based lossy encoder according to the prior art;

Figure 2 shows a block diagram of a DCT-based lossy encoder according to an embodiment of the present invention;

Figure 3 shows byte-size vs zero-value index relationships for respective test images;

Figure 4 shows the zero-value indices obtained with a number of different quantisation tables (Q) for an image to be compressed; and

Figure 5 is a flow diagram illustrating a method of compressing an image.

The general architecture of a DCT-based encoder embodying the present invention is shown in Figure 2. This is a modification of the encoder already described with reference to Figure 1, and like parts are identified with the same reference numbers. The encoder is suitable for use in the compression of still frames in accordance with the JPEG standard, although it may also be used to satisfy other compression standards and methods. A conventional decoder may be used to decode images compressed with this encoder.

The encoder of Figure 2 comprises a modified quantisation table selection unit 11. This is arranged to store a look-up table or other representation of the relationship between the size of a compressed image (termed the 'bit budget') and an index termed the 'zero-value' index. As has already been explained above, the DCT obtained for each block 3 of an image 2 contains a set of DCT coefficients, a large number of which may be zero after quantisation. For a given image, the zero-value index of that image is determined by counting the number of zero-value quantised coefficients in each DCT, and determining the average number of zero-value coefficients per DCT.

The stored relationship is constructed using a number of library or test images, chosen to be representative of a number of different styles, for example images containing little detail, e.g. sky, and images containing a large amount of detail, e.g. landscapes. Each test image is processed by sub-dividing the image into blocks and determining the DCT for each block. This set of DCTs is then quantised with each of the quantisation tables (Q=1 to 100) in turn, where the tables are generated from the base table (Q=50) using the following relationships:

$$\text{for } Q<50; \quad k=\frac{5000}{Q}; \qquad TB_Q[i,j]=\frac{TB_{50}[i,j].k+50}{100}$$

$$\text{for } Q>50; \quad k=200-2Q; \qquad TB_Q[i,j]=\frac{TB_{50}[i,j].k+50}{100}$$

where $TB_{50}[i,j]$ is the quantisation step for the base table element in the i th row and the j th column and $TB_Q[i,j]$ is the quantisation step for the new table element in the i th row and the j th column. $TB_Q[i,j]$ are in practice also rounded to the nearest integer.

The resulting quantised DCTs are encoded using run-length encoding and entropy encoding (i.e. Huffman encoding). The size of the compressed image (bit budget) is then determined. In addition, the zero-value index is calculated for each set of quantised DCTs. Figure 3 shows the zero-value index vs bit budget for a number of different test images. This set of relationships is then averaged to generate an archetypal relationship. It is found that in general the zero-value index vs bit budget relationship of an image deviates little from the archetypal relationship.

The archetypal relationship is stored as already described in the modified quantisation table selection unit 11, typically as a look up table. A new digitised image to be compressed is passed, block by block, to the FDCT 4 to generate a DCT for each block. A quantisation table corresponding to Q=97 is generated by the modified quantisation table selection unit 11, from the table specification memory 6, for use by the quantiser unit 5 to quantise each DCT in turn. The number of zero-value coefficients in each DCT is then determined and the zero-value index calculated.

Using the set of quantised DCTs, it is also possible to determine the zero-value index for lower Q values. For example, it can be seen that all coefficients $TB_{97}[i,j]$ having the value 1 will have the value 0 after quantisation with Q=91. It is therefore only necessary to count the number of 0's and 1's in each DCT with Q=97, and find the average per block, to determine the zero-value index for Q=91. There is shown in Figure 4 a plot of Q value vs zero-value index for one particular image.

Assuming that a particular bit budget has been predefined (BB) for the compression stage, the relationship illustrated in Figure 3 and held by the quantisation table selection unit 11, can be used to identify that zero-value index (a 'predicted' zero-value index) which will meet the bit budget. The identified zero-value index can then in turn be used, in conjunction with the specific relationship of Figure 4, to identify the Q value which will achieve this bit budget for the image under consideration. The quantisation table corresponding to that Q value is then generated and applied by the quantiser unit 5 to

quantise the set of DCTs for the image. The quantised DCTs are then applied to the run length encoder 7 and to the entropy encoder 8 as already described to generate the compressed image.

Figure 5 is a flow diagram illustrating the method described above.

It will be appreciated by the skilled person that modifications may be made to the above described embodiment without departing from the scope of the present invention.

Claims

1. A method of compressing a digitised image composed of a matrix of image samples to provide a compressed image which satisfies a predefined bit budget, the method comprising the steps of:

1) dividing the digitised image into blocks and deriving for each block an energy packing transform comprising a set of transform coefficients;

2) selecting a quantisation table from a set of quantisation tables and using the selected table to quantise the coefficients of each transform;

3) deriving a zero-value index indicative of the number of zero-value quantised transform coefficients;

4) determining a predicted zero-value index using said predefined bit budget;

5) selecting a quantisation table from said set of tables using the derived index and said predicted index and using that selected table to quantise the coefficients of each transform; and

6) compressing the coefficients quantised in step 5) using run-length encoding.

2. A method according to claim 1, wherein said zero-value index is the average number of zero-value quantised transform coefficients per transform.

3. A method according to claim 1 or 2, wherein step 3) comprises deriving zero-value indices for each of a plurality of different quantisation tables to provide a zero-value index vs quantisation table relationship.

4. A method according to any one of the preceding claims and comprising obtaining a reference zero-value index vs bit budget relationship by:

7) dividing a digitised test image into blocks and deriving for each block an energy packing transform comprising a set of transform coefficients;

8) selecting a quantisation table from a set of quantisation tables and using the selected table to quantise the coefficients of each transform;

9) deriving a zero-value index indicative of the number of zero-value quantised transform coefficients;

10) compressing the coefficients quantised in step 5) using run-length encoding;

11) determining the bit size of the compressed image;

12) repeating steps 7) to 11) for a plurality of different quantisation tables to obtain a zero-value vs bit size relationship for the test image; and

13) repeating steps 7) to 12) for a plurality of different test images and combining the resulting relationships to obtain the reference zero-value index vs bit budget relationship,

wherein this relationship is used in step 4) to determine the predicted zero-value index using the predefined bit budget.

5. A method according to claim 4 when appended to claim 3, wherein step 5) comprises using the predicted zero-value index and the zero-value index vs quantisation table relationship for the image to be compressed, to select the quantisation table.

6. A method according to any one of the preceding claims, wherein said energy packing transform is a discrete cosine transform (DCT).

7. A method according to any one of the preceding claims, wherein step 6) comprises entropy encoding the data after run-length encoding.

8. Apparatus for compressing a digitised image composed of a matrix of image samples to provide a compressed image which satisfies a predefined bit budget, the apparatus comprising:

first signal processing means for dividing the digitised image into blocks and for deriving for each block an energy packing transform comprising a set of transform coefficient;

a quantisation table specification memory (6) storing a set of quantisation tables;

quantisation means (5) for quantising the coefficients of each transform using a first quantisation table selected from said set of quantisation tables;

second signal processing means (11) for deriving an index representative of the number of zero-value quantised transform coefficients, for determining a predicted zero-value index using said predefined bit budget, for selecting a quantisation table from said set of tables using the derived index and said predicted index and using that selected table to quantise the coefficients of each transform; and

encoding means (7,8) for compressing the coefficients quantised by the second signal processing means using run-length encoding.

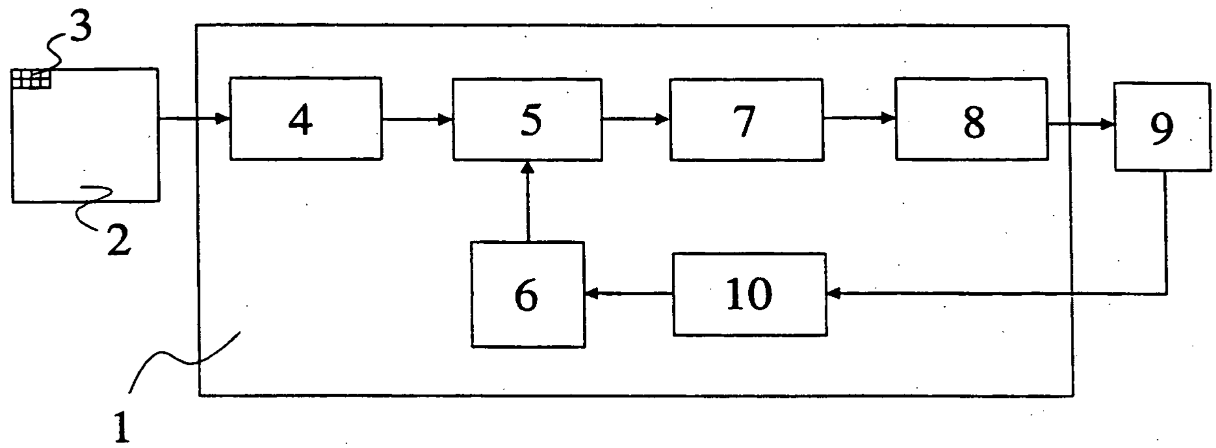


Figure 1

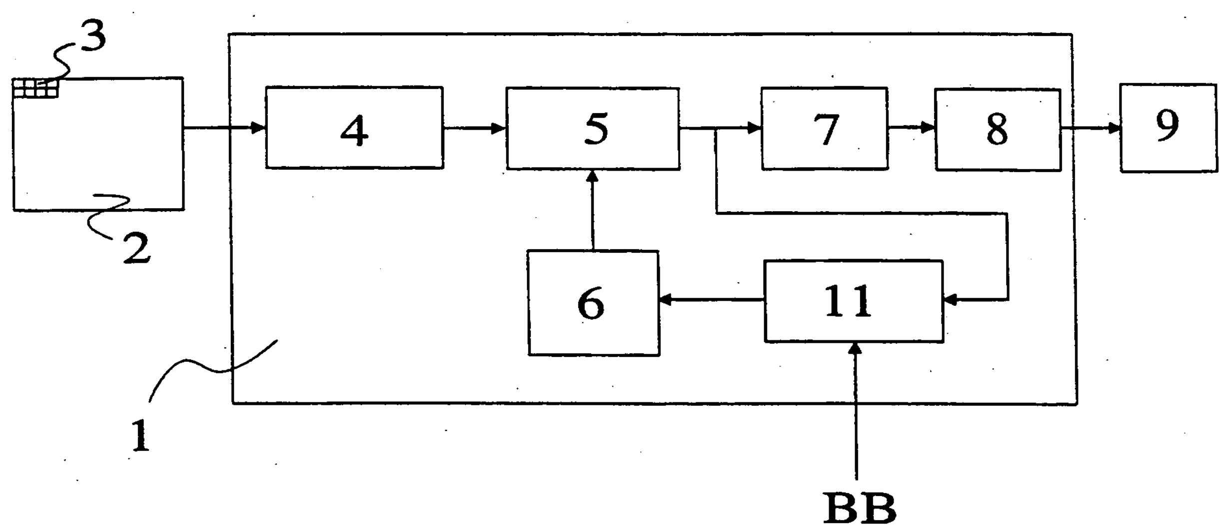


Figure 2

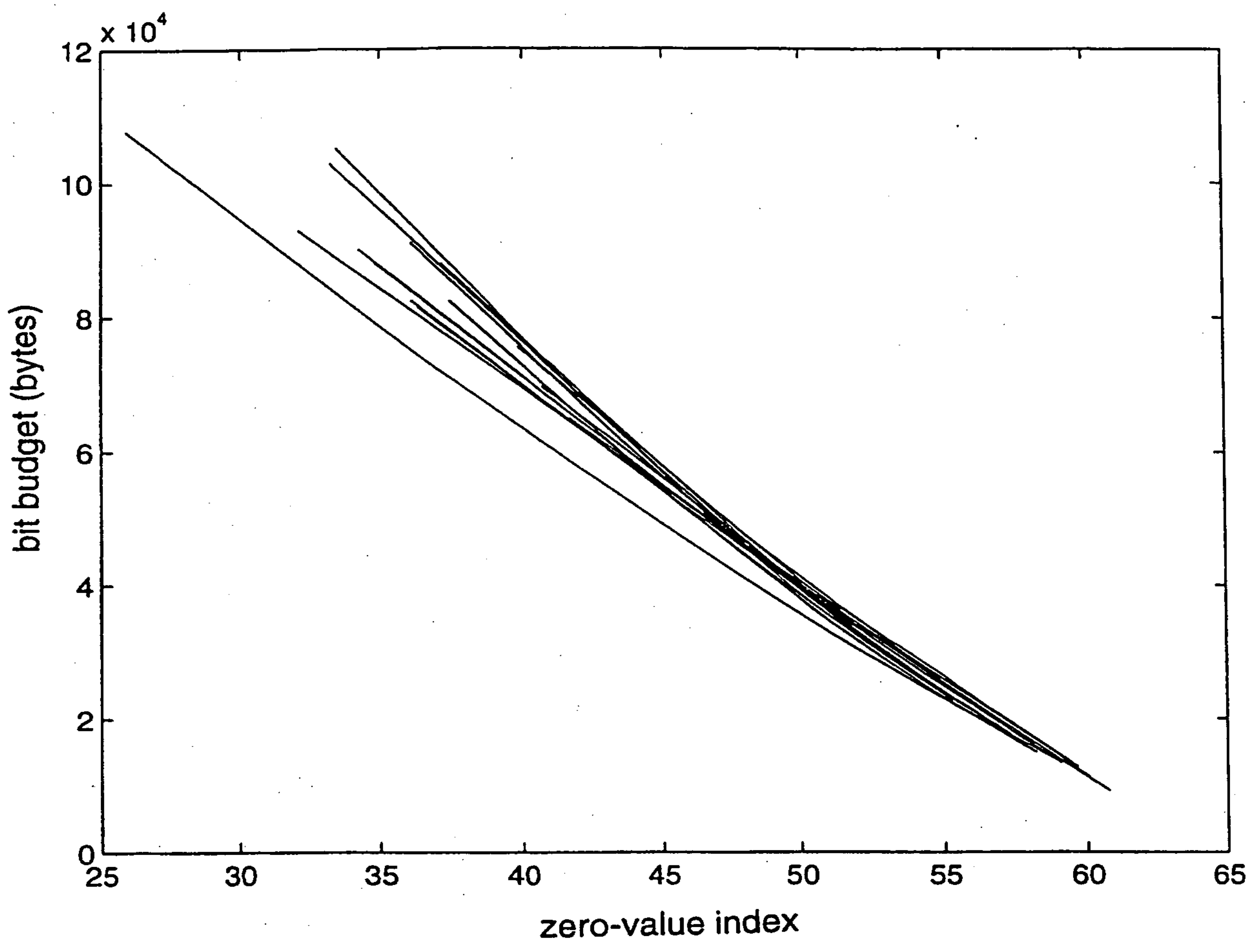

x 10^4
12
10
8
6
4
2
0
bit budget (bytes)
25
30
35
40
45
50
55
60
65
zero-value index

Figure 3

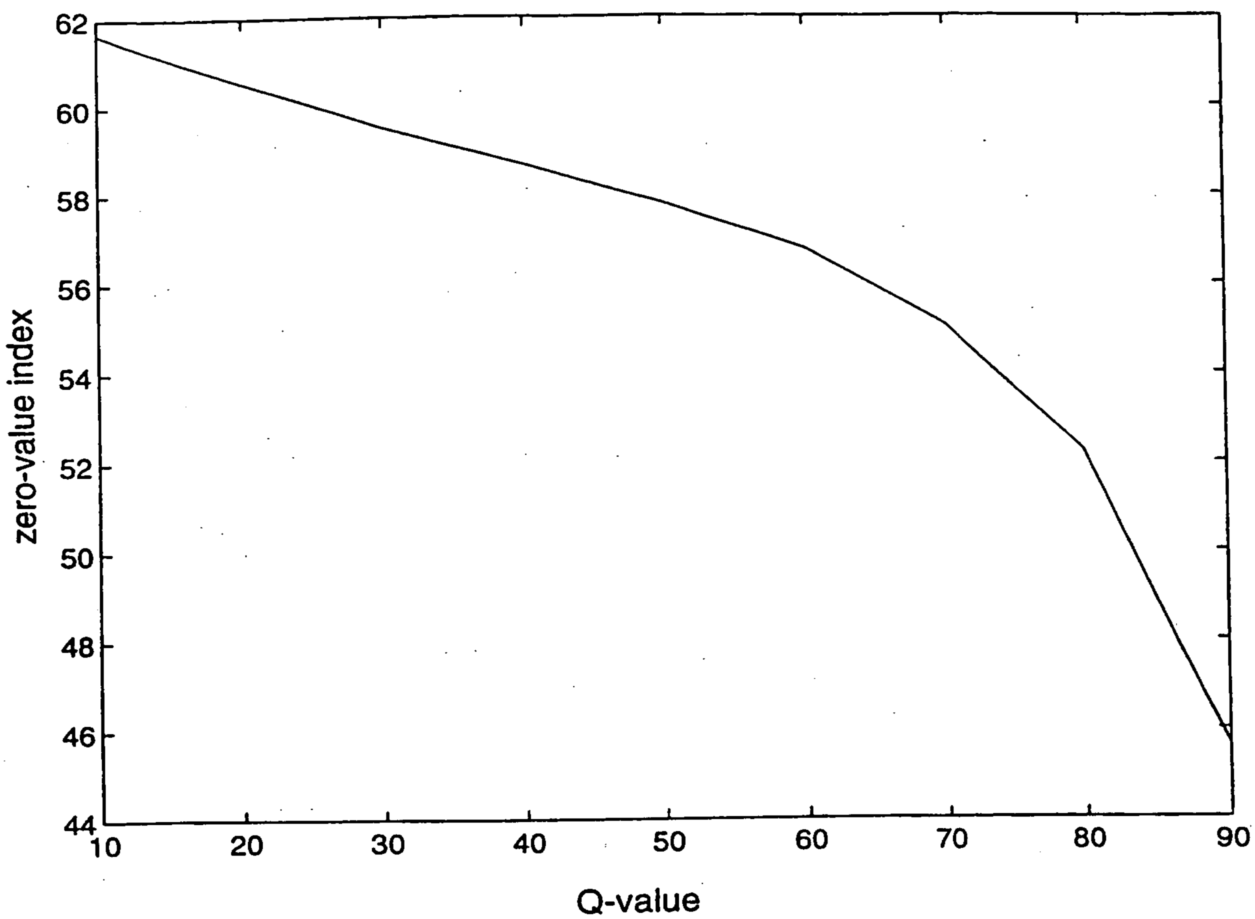

62
60
58
56
54
52
50
48
46
44
zero-value index
10
20
30
40
50
60
70
80
90
Q-value

Figure 4

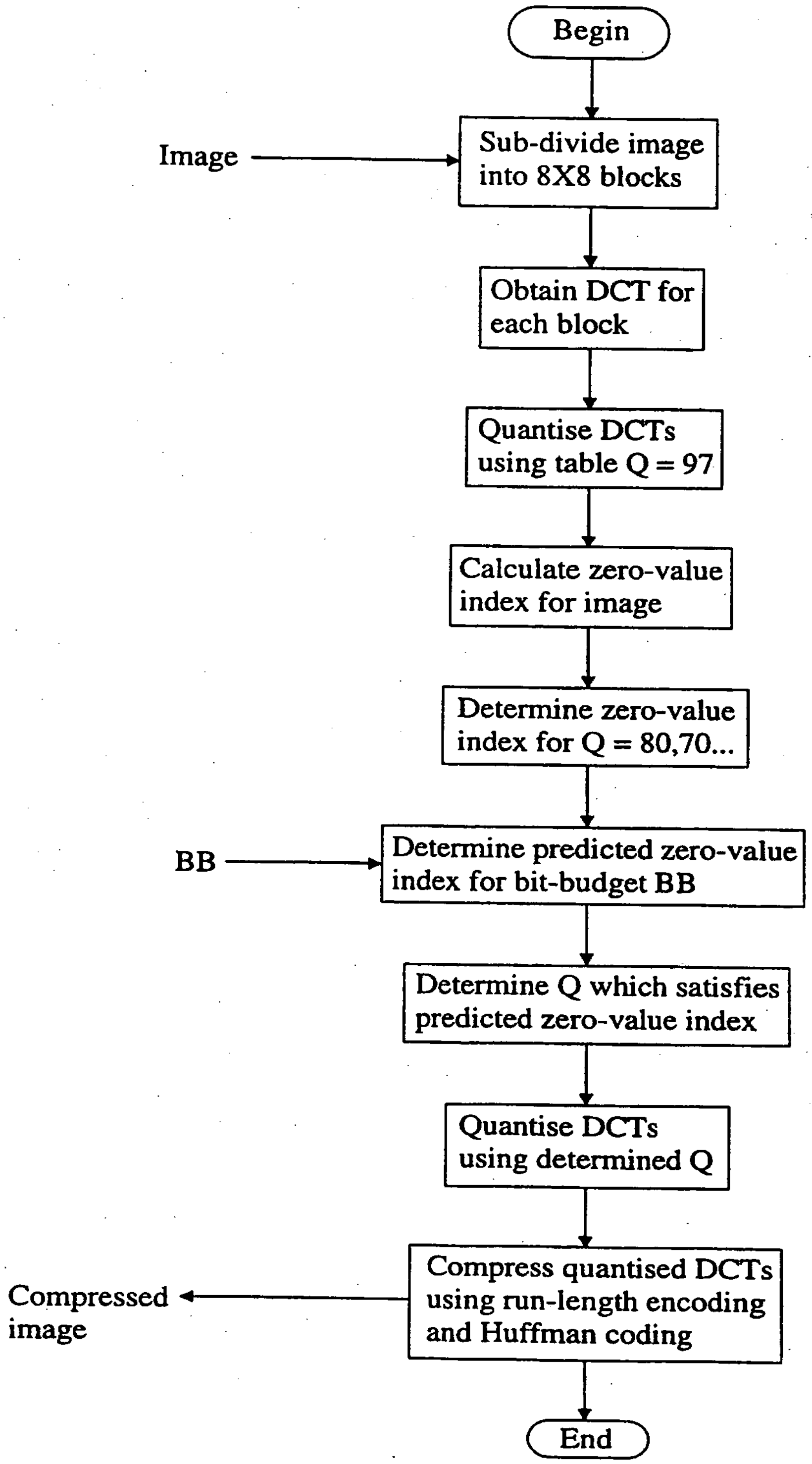

Begin
Image
Sub-divide image into 8X8 blocks
Obtain DCT for each block
Quantise DCTs using table Q = 97
Calculate zero-value index for image
Determine zero-value index for Q = 80,70...
BB
Determine predicted zero-value index for bit-budget BB
Determine Q which satisfies predicted zero-value index
Quantise DCTs using determined Q
Compress quantised DCTs using run-length encoding and Huffman coding
Compressed image
End

Figure 5

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04N 7/50, 7/30 | A3

(11) International Publication Number: WO 99/04553

(43) International Publication Date: 28 January 1999 (28.01.99)

(21) International Application Number: PCT/FI98/00512

(22) International Filing Date: 12 June 1998 (12.06.98)

(30) Priority Data:
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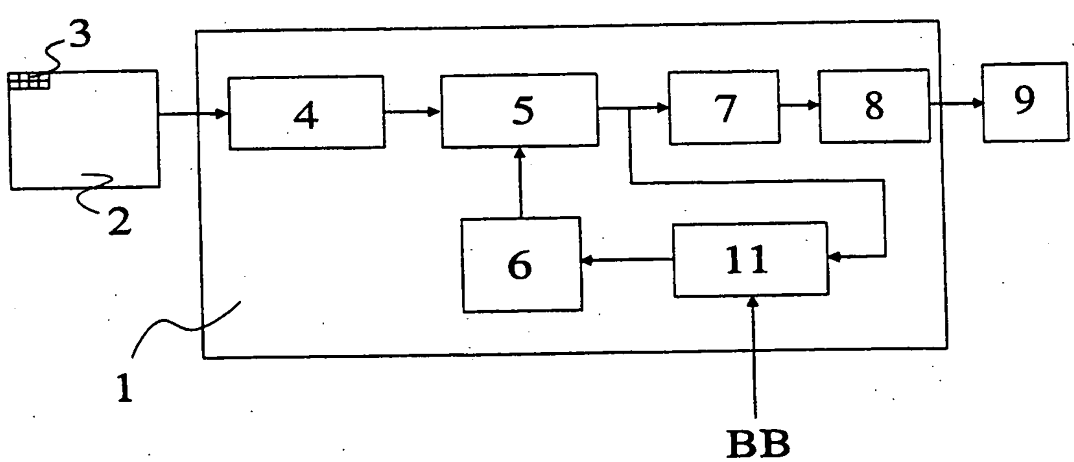
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(88) Date of publication of the international search report: 8 April 1999 (08.04.99)

(54) Title: IMAGE COMPRESSION



(57) Abstract

A DCT based lossy compresion method for compressing a digitised image composed of a matrix of image samples to provide a compressed image which satisfies a predefined bit budget. The digitised image is first sub-divided into blocks (e.g. of size 8X8 pixels). A discrete cosine transform (DCT) comprising a set of DCT coefficients is then derived for each block. A quantisation table is selected from a set of quantisation tables and, using the selected table, the coefficients of each DCT are quantised. A zero–value index, corresponding to the average number of zero value quantised DCT coefficients per DCT, is determined. A predicted zero–value index is calculated using said predefined bit budget and a quantisation table selected from said set of tables using the determined index and the predicted index. Using that selected table, the unquantised coefficients of the DCTs are requantised and the requantised coefficients compressed using run–length encoding and Huffman encoding.

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INTERNATIONAL SEARCH REPORT

I. national application No.
PCT/FI 98/00512

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04N 7/50, H04N 7/30
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9717675 A1 (SIEMENS MEDICAL SYSTEMS, INC.), 15 May 1997 (15.05.97), abstract --	1-8
A	EP 0743793 A2 (LG ELECTRONICS INC.), 20 November 1996 (20.11.96), abstract --	1-8
A	EP 0762775 A2 (HEWLETT-PACKARD COMPANY), 12 March 1997 (12.03.97), abstract --	1-8
A	WO 9319434 A1 (ZORAN CORPORATION), 30 Sept 1993 (30.09.93), abstract --	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 January 1999	27 -01- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Michel Gascoin Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 98/00512

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0514188 A2 (CANON KABUSHIKI KAISHA), 19 November 1992 (19.11.92), abstract -- --------	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/12/98

International application No.
PCT/FI 98/00512

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9717675 A1	15/05/97	EP 0859995 A	26/08/98
EP 0743793 A2	20/11/96	CN 1157441 A	20/08/97
		JP 9055938 A	25/02/97
		US 5822461 A	13/10/98
EP 0762775 A2	12/03/97	JP 9130802 A	16/05/97
		US 5677689 A	14/10/97
WO 9319434 A1	30/09/93	EP 0630506 A	28/12/94
		JP 7505268 T	08/06/95
		US 5699457 A	16/12/97
EP 0514188 A2	19/11/92	JP 4341064 A	27/11/92
		US 5657399 A	12/08/97
		JP 4341066 A	27/11/92